

DESIGNING OF COURSE MATERIAL FOR E-LEARNING IN PHOTOGRAMMETRY

J. Höhle

Aalborg University
Laboratory for GeoInformatics
Fibigerstraede 11
DK 9220 Aalborg Øst, Denmark
jh@land.aau.dk

Commission VI, Working Group VI/2

KEY WORDS: Learning, Internet/Web, Teaching, Training, Photogrammetry, Orientation, Automation

ABSTRACT:

Distance learning via the Internet (e-learning) requires good course material and a high degree of interactivity. On the basis of an e-learning course of the European Organisation for Spatial Data Research (EuroSDR, formerly OEEPE) about a photogrammetric research topic various tools for producing the user interface, the knowledge pages, multiple-choice quizzes, and interactive learning programs are described. The applied tools for the course "Automatic Orientation of Aerial Images on Databases" of the OEEPE/EUROSDR educational service 2002 and 2004 include standard software packages like "FrontPage", "QuizMaker", and "Flash MX" as well as programming tools like "Java", "ActionScript", "php-script", and "MathLab". The derived course material is either embedded into the Computer Conference System ("FirstClass"), which has to be installed on the client computer or is used within the browser "Internet Explorer". A specially designed template is the start page of the Internet-based course material. It serves as the user interface and integrates the knowledge pages, literature, assignments, self-assessment modules, and learning programs. Experiences with the repeated conduction of the course with international participants, the updating and maintenance of the course material, and the quality assessment by the participants are presented. The contents of the course material cover a recent research topic in photogrammetry, which will be summarized only. The described design and production of e-learning courseware can be applied to other fields as well, and the article can be considered as a technical guide for e-learning and implementation of courseware. E-learning will increase in the next years and the recommendations in this contribution may be of help to all teachers and other people who wish to develop or have to develop educational material for use at the Internet.

1. INTRODUCTION

In our times of great changes a lifelong education is very much in demand. Professional people in practice want to update their knowledge and learn new subjects beside their regular work. This need can be fulfilled by e-learning courses, which will give the participants a lift in competence and advancements in their professional career. The demands for good e-learning courses are very high. The new achievements in the information and communication technologies like the Internet allow universities as well as other educational institutions to participate in the growing task of such continuing professional training. Furthermore, the regular study programmes at the universities also have to adapt to the needs of students who wish to study at any time and at any place.

E-learning can have different goals, forms, costs, and applications. It may be categorized with three types. The first type is an **open-university education**. By performing a university-level educational programme with the support of e-learning technology, professional people in practice can then study new subjects beside their regular work and in their hometowns or wherever they are. As an example, a competence-giving education, which finishes with a Master of Technology Management (MTM) degree in Geoinformatics, can be provided by one of the current educational programmes at Aalborg

University, Denmark. The education takes two years and requires for an average student 20 hours of study per week. This workload relates to one year of study in direct learning. A further example in this category is the curriculum of the Institute for Education in Geospatial Sciences at the University of Mississippi, USA. At this university 50 e-learning courses in the Geospatial Sciences are currently developed.

Another type of e-learning is **short courses**, which last only a few weeks and comprise a single subject. The courses of the European Organisation for Spatial Data Research are an example of this type of e-learning. The EuroSDR courses start with a two-day introductory seminar, which is then followed by a two-week e-learning for each course. Four courses on advanced themes, mainly based on recent research projects of the EuroSDR, are carried out at the moment. A diploma for successful participants is handed out after the participants have done several assignments. This paper discusses the design of proper courseware for this type of e-learning.

A third type of distance learning is **self-study by means of tutorials**. Companies or other organisations, which produce software packages and data sets, often provide special learning software. Such a tutorial can be used directly at the Internet. The student may obtain support by a service unit or a discussion

group, which answer his or her questions. The “Virtual Campus” of the Environmental Systems Research Institute, Inc. (ESRI), is an example of such educational material (see also the Web addresses of the mentioned institutions under references).

2. GENERAL CONCEPTS IN DISTANCE LEARNING

There are different components, which belong to distance learning: Contents of the courses, applied pedagogy (including the courseware and the assessment) and technology.

2.1 Contents

The topics to be taught will mainly be from new fields. The enormous changes in photogrammetry and remote sensing give rise to many new topics to be learnt, and the gained knowledge can then hopefully be used at work. The integration within geographic information technologies has created many new job opportunities. A new name for the whole field of knowledge was created: Imaging and geo-spatial information science and technologies. The learning about that field can be at a broad level or in depth.

2.2 Pedagogy

E-learning requires first of all good course material. Furthermore, short reaction times to the participants’ questions and answers are expected. A strict scheduling of the work with the course material is helpful. The participant must get the feeling that he is not lost in the virtual space and that he makes progress. Clearly defined goals and continuous feedback are very important to his or her motivation. The social components have to be taken into account too. The assessment methods and the quality control are also important parts of this type of education.

2.3 Technology

In order to motivate a lonely participant at a remote place, efficient and reliable communication facilities with his teachers and his fellow students are of great importance. In the present e-learning the Internet and a conference or communication system play an important role.

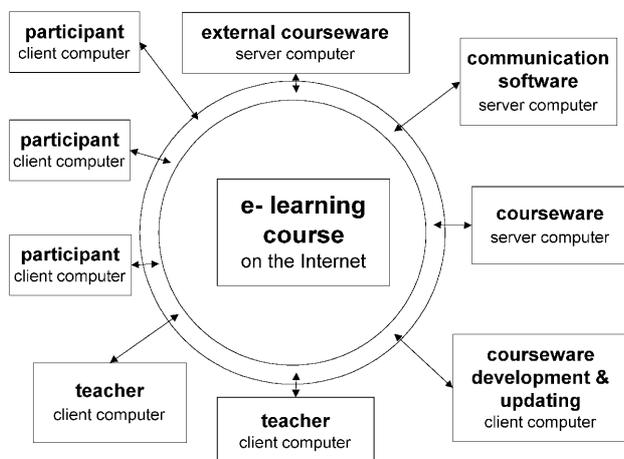


Figure 1. Course participants and courseware using client and server computers.

There is a wealth of educational material to find at the Internet. Interactive learning programs can be used on-line and the latest version of the learning program is thereby installed. Such programs can be downloaded and used in an off-line mode as well. A simulation program for a server may then be necessary. The Internet can also be used as a computer where heavy computing takes place at a server only. The server computer hosts the courseware which then is used from the client computers. Figure 1 gives an overview how the client and server computers interact with each other and which are the components of e-learning.

3. EUROSDR E-LEARNING COURSES

The European Organisation for Spatial Data Research has organized e-learning courses since 2002. The courses are based on research projects of EuroSDR and the results of these research projects are learned in depth and with the goal that new technologies and methods are used later on by the national mapping agencies, private firms and universities of the member states. A task force of EuroSDR organizes the educational service for each year. It selects the topics and the teachers of the courses. The teachers are recruited from the group of EuroSDR project leaders or from universities who have experience of the selected topic and e-learning.

3.1 Contents

Currently five courses are prepared: Integrated sensor orientation (course A), automatic orientation of aerial images on databases (course B), airborne laser scanning and interferometric SAR (course C), digital cameras/sensors and data fusion (course D), and co-ordinate reference systems (course E). Other knowledge of the course contents originates from EuroSDR seminars and/or workshops. Each e-learning course requires about 30 hours of work from the participants.

3.2 Pedagogy

The participants have different technical background. They are professionals of the European national mapping agencies and of private firms as well as PhD students or master students of universities. E-learning is unknown to most of the participants. Culture differences in the relation between teacher and participant may exist. Therefore, a compulsory two-day introductory seminar is held at the beginning of a bunch of courses, where the participants and teachers get acquainted to each other and where an introduction to the topics and the courseware is given. During the courses the progress of the learning is tested by the participants themselves (self-tests) and also by the teacher. His or her answers to the questions and problems of the participants have to be given promptly within 48 hours during the two weeks of the course. A certificate of "successful attendance" is given if the participants have actively participated and passed a final test.

3.3 Technology

The participants of the e-learning courses must have access to the Internet. A communication and conference system is very helpful. A browser (for example Internet Explorer) and an e-mail program (for example Eudora) is a more simple and cheaper solution. The use of the computer conference system "FirstClass" (FC) requires the installation of the client software

"FC_GOLD" from a CD. Login to FC occurs with a password. Basically FC is an easy-to-use and proven communication and conference system. Each course has its own "conference". Mail to conferences can be read and written by all the participants of the course. The teachers send literature, assignments and comments to the participants; the participants send answers and questions to the teacher. It can be monitored if the addressee has opened his mail. A group calendar informs about the schedule of the course. Communication between the participants and the teacher can also be carried out by means of chatting where several persons can take part at the same time. The browser has to have some plug-ins in order to receive and to display different types of courseware (compare figure 2). General plug-ins are the pdf-file reader (for example Acrobat Reader) and the Flash Player. A special plug-in is the Java byte code interpreter (also called Java Virtual Machine) that translates applets into machine code of the used client computer. Here it may be essential that the version of the Java compiler contained in the Java Development Kit (JDK) is equal to the version of the Java plug-in of the browser. Otherwise the run of the applet may fail or the layout may appear differently on the computer screen than designed (Höhle, J. and J.A. Hyldahl, 2001). Besides the electronic means of communication, hard-copy material such as books and CDs, is handed out to the participants of the EuroSDR courses. The mixture of hard-copy material and electronic material may disappear when e-learning is more used in future.

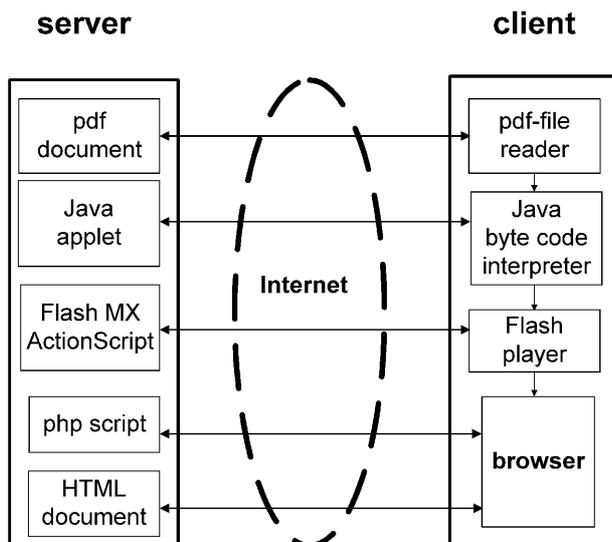


Figure 2. Interactive learning programs use HTML- and pdf-documents, Java applets, ActionScripts, and php scripts, which all reside on a server computer. Applets are interpreted on the client computer by the Java byte code interpreter into machine code. Learning programs produced by the Flash MX tools of Macromedia are displayed by the Flash player. Interactivity in the learning programs is created by ActionScript available in Flash MX. Php scripts are converted into HTML files at the server, transferred to the client computer and displayed by a browser. Documents in pdf-format are displayed on the client computer by means of pdf-file reader, for example Acrobat Reader. All of the displayed boxes on the client computer are plug-ins of a browser.

4. DESIGN OF COURSEWARE

The courseware of e-learning courses is essential for the success of the courses. The design of courseware has to be planned carefully with regard to the contents, the pedagogy and the technology. The contents are given by the EuroSDR research project. A general introduction into the topic may be necessary. The participant should learn by doing. A high degree of interactivity makes the learning much more interesting. He or she should experience the progress in learning. Different assignments should be attached. It should be possible to make self-tests. The production of courseware should be possible with reasonable costs, and appropriate tools should be available. A team of teachers and multimedia specialists should preferably do the design and the realisation together. The created courseware has to be tested thoroughly. It has also to be updated according to the gained experiences and the updating should be as easy as possible. Basically the courseware consists of a user interface, literature, learning programs, multiple-choice quizzes and assignments. In the following the parts of the courseware are explained by means of course "B" of the EuroSDR e-learning courses, but in a generalized manner. The contents of this course and the applied tools are dealt with in the next chapters.

4.1 User interface

The user interface of a course contains the contents of the course, the learning aids and instructions how to proceed with the learning. Figure 3 shows the general layout for the start page, which the user is confronted with when the Web address (URL) of the course is typed into the browser. The window area on the upper right side is used for a short introduction into the selected topic. Graphics are used to supplement the text lines. The selectable learning aids are literature to be read, self-evaluation quizzes, and several learning programs. They will start when the user clicks the corresponding hypertext.

4.2 Literature

Literature to be read by the participants may reside at various servers at the Internet. Links to the original articles are established if the various authors have granted permission. The literature includes first of all the EuroSDR research report, which is available at the Internet as a pdf-file. Furthermore, presentations at the introductory seminars, for example the overview of the topic, are available at the Internet in HTML or PowerPoint format. Data of the EuroSDR research project are made available as well.

4.3 Learning programs

Learning programs also include practical work to be done by the participants. The given tasks require interactions with the program and its data sets. Experiments have to be carried out and the data sets are altered. These special programs also include self-tests. Basic knowledge is provided at the beginning by means of dynamic images and moving text lines. The information is stored in various layers. The topics can be basic knowledge in digital photogrammetry or they can directly be connected to the research project. Computations are carried out either on-line (by means of a program) or by the participant, who uses the calculator or spreadsheet of the learning program.

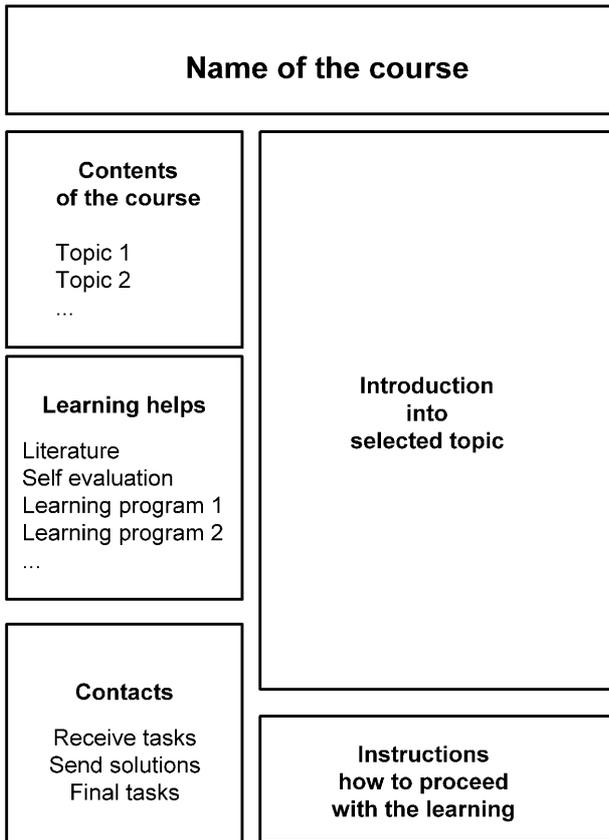


Figure 3. User interface of the described e-learning course

4.4 Self-evaluation tests

Multiple-choice quizzes are usable for a self-evaluation whether the read literature was understood. The presented questions are answered by marking one of two or three possibilities.

4.5 Assignments

Assignments (tasks) are given to participants after each topic. These are a couple of questions, which have to be answered by a short text or some calculations. The participants will receive from the teacher a standard answer or an individual answer. After reviewing the comments he or she may wish to read again some of the literature or use the learning programs before continuing to the next topic. Figure 4 makes the steps of learning more clear. Frequently asked questions and the answers may be placed in a conference so that all of the participants can take advantage of them.

4.6 Final assignment

After the participants have worked with all of the topics a final assignment (task) will be given at the end of the course. The participants have to pass this test in order to receive the diploma of successful attendance.

5. TOOLS FOR THE PRODUCTION OF COURSEWARE

The tools for the production of courseware are very similar to the tools for the production of Web pages. In recent years a rapid development of design tools for Web pages has taken place and this is still going on. A good performance of Internet-

based courseware (as regards speed and safe operation) is achieved if client **and** server software is developed. In addition, the development of computers, networks, and programming languages has contributed very much so that sophisticated learning programs can run at the Internet.

The tools of the individual elements of the courseware differ. They are dealt with in the same order as in the previous chapter and are based on the development of course "B" of the EuroSDR e-learning.

5.1 User interface

A Web authoring program produces the user interface as depicted in Figure 3. "FrontPage" of Microsoft (MS) and "Dreamweaver" of Macromedia are such programs. The Netscape composer, which is integrated into the Netscape browser, is also useful, especially if simple changes (updates) have to be carried out only. The incompatibility between the mentioned tools may give problems if several of these programs are used for the same task. Toolboxes for Web graphics designs exist, which help to create logos, buttons and templates, and they can be taken directly from there. An example is (Voska, R., 2001).

5.2 Literature

The literature is created in MS Word or another text-processing program and then converted into pdf-format by the same program or by Acrobat Distiller. In this way the literature is displayed for all of the participants in the same way. Presentations at the introductory seminars are produced by means of Netscape composer in HTML (Hyper Text Markup Language) and can - after uploading onto a server- be displayed on a client computer.

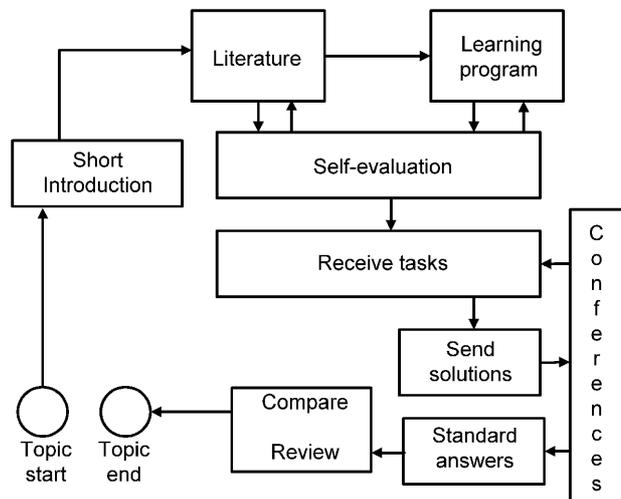


Figure 4. Steps at an e-learning course

5.3 Learning programs

The used tools for three different learning programs reach from programming languages like Java to authoring programs like Flash MX. More information about these tools can be found in (Flanagan, D., 2002) and (Leete, G. and E. Finkelstein, 2002), respectively. The production of courseware already starts with the preparation of the images and numerical examples. Programming in MathLab as well as image processing by means

of Adobe's Photoshop program were carried out. Learning programs where computational tasks are carried out on-line were produced by means of the Java language. An efficient tool for generation of animations and interactive elements is Macromedia Flash MX. The interactions are written (or automatically generated) in the ActionScript programming language. Some parts of the learning programs require programming in php script, which is executed on-line at the server computer. The results are HTML code files, which are sent via the Internet to the client computer (compare left side of figure 2).

5.4 Self-evaluation tests

Interactive quizzes have been created in order to enable a self-evaluation. They are carried out at the Internet. Various programs and services are available from different sources. For example, the QuizMaker for QuizServer of R. Shadian, University of Hawaii, USA, allows for different types of quizzes. You may select "true-false" or "multiple choice". Radio buttons are used to mark the answer of the user, and the program then tests whether the delivered answer is correct. Images and graphics can be used in the quiz as well.

5.5 Assignments

The assignments (tasks) are mainly questions that are written in HTML code and called by the hypertext "Receive tasks". They are then displayed on the right side of the described user interface (compare figure 3). The final assignments (tasks) are written as e-mail including attachments in the Word format and sent to the participants by a mail program.

6. THE LEARNING PROGRAMS OF THE COURSE "AUTOMATIC ORIENTATION OF AERIAL IMAGES ON DATABASES"

The course "B" of the EuroSDR e-learning includes three learning programs. They form the core of the course and give the participants practical experience about procedures and problems at automatic measurements of image points as well as insight in the methods of automatic orientation of aerial images on databases. Details of the research project are published in (Höhle, 1999).

The first learning program, "LDIPInter", introduces correlation techniques and gives assignments (tasks) for calculation of image positions in 1D and 2D, with and without sub-pixel accuracy and applies the techniques to the automatic measuring of crosses and the automatic orientation of aerial images. The second learning program, "Auto_Orient", deals with practical details of the "Automatic orientation of aerial images on databases". The third program, which will be used in 2004 for the first time, is "LDIPInter2". The name stands for "Learning Digital Photogrammetry", part 2, and the program deals with several correlation (matching) techniques: Area-based matching, feature-based matching and least squares matching. An application of the techniques is also included: The test of digital elevation models by means of two orthoimages.

All three programs have a knowledge part and a task part. The given answers and solutions to the given tasks are tested and feedback is given to the user. The figures 5 and 6 give some ideas about the contents and the layout of the last two programs.

Theme 3: Area Based Matching



Task 3.2: Apply different geometric and radiometric models.

Method	Geometric model	Radiometric model	Number of parameters
A	Shifts only	--	2
B	Helmert transformation	--	4
C	Affintransformation	--	6
D	Affintransformation and resampling	Shift and scale	8

Press key for method (A, B, C, or D) and observe results of matching.

Buttons: A, B, C, D

Template:

Search area:

Resampled search area:

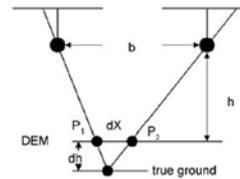
σ_{col}	0.012
σ_{row}	0.012
Number of iterations	5

Which is the most accurate method? D Check The answer is correct

Buttons: Return to Main, Information, Help, Next theme, Knowledge, Quit

Figure 5. Task part of the learning program "LDIPInter2". In the theme on Area Based Matching the user can test different geometric and radiometric models. The achieved accuracy in the co-ordinate measurements will be displayed and the question "Which is the most accurate method?" has to be answered. The given answer is analysed and the learning program displays a comment.

Theme 4: Application "Checking of Digital Elevation Models"



- Digital Elevation Models (DEMs) can be checked and improved by two orthoimages
- orthoimages are derived from two [overlapping aerial images](#) using the same DEM
- a [parallax](#) between the two orthoimages will show up if the DEM has some errors
- this parallax can be measured and converted to an [error of height \(dh\)](#)
- the parallax can automatically be measured by means of [correlation techniques](#)
- the DEM can also be improved when the measured height errors are used as [corrections](#)

Buttons: Return to Main, Information, Help, Task, Repeat, Stop, Quit

Figure 6. Knowledge part of "LDIPInter2". The matching of image patches is applied to automatic parallax measurement between two orthoimages. The parallaxes are then converted to errors of the digital elevation models and the DEM can in this way be improved. The learning program explains the method by means of running text lines. More information is given in windows which pop up when the user clicks on the hypertext. The literature to this method, (Höhle et al.), can be downloads from a server.

7. SOME EXPERIENCES FROM E-LEARNING

The participants of the first Euro-SDR e-learning courses evaluated the courses by means of questionnaires. Also the teachers of the courses discussed their experiences. The first findings were published in (Höhle, 2003), (Tempfli, 2003) and

(Heipke, 2004) and then used for improvements of the courses in 2004. Only a short summary of the experiences will be given here. All of the responses from the course in 2002 judged that the courses were useful, and most of the responses indicated that the goals for the courses have been achieved. All wrote that the course material was appreciated and that additional hardcopy material was useful. The majority managed the installation of the communication software "FirstClass" (FC) without difficulties. Firewalls at some organisations, however, called for the browser version of FC. The combination of introductory seminar and e-learning was answered positively by 71%. The question about participation in a new course was answered with a yes in 73% of the responses. As a matter of fact, the course in 2004 had also a few participants from the year 2002. The experiences from all four e-learning courses in 2004 will first be available at the time of the XXth ISPRS congress.

8. CONCLUSION

E-learning will increase considerably in future; there is a big need in the continuous training of professionals. E-learning courses have three elements: contents, pedagogy and technology. All three need proper attention when the courses are planned. Good courseware is very essential for the success of e-learning courses. It should be carefully designed by a group of teachers and be updated with the experiences from its use. More and more tools are becoming available for the design and the production of courseware. Interactive learning programs use learning by doing and they are an important part of the courseware. They can now be produced more efficiently by means of authoring tools like Macromedia FLASH MX. More sophisticated learning programs with on-line computations and a high flexibility require programming in languages like JAVA. The described design and production of e-learning courseware can be applied to other fields as well, and the article can be considered as a technical guide for e-learning and implementation of courseware.

ACKNOWLEDGEMENTS

The author wants to thank B. Nørskov for proofreading. Special thanks go to M. Potucková and E. Jensen, both of Aalborg University, who assisted the author in the production of the learning programs "Auto_Orient" and "LDIPInter2". Furthermore, the cooperation with the members of the EuroSDR task force on education is very much appreciated.

REFERENCES

Heipke, C., 2004. Der Educational Service von EuroSDR, 8 p., proceedings of the DGPF-seminar on e-learning, Vechta, Germany.

Höhle, J., 1999. Automatic orientation of aerial images on database information, OEEPE Official publication No. 36, pp. 71-191.

Höhle, J., 2001. From a research project to an Internet based educational package, in: Proceedings of the conference "Computer based learning in science" (CBLIS '01), Brno, Czech Republic, A7, 9p., ISBN: 80-7042-180-0

Höhle, J., 2003. Report on the first three OEEPE e-learning courses, NEWSLETTER EuroSDR, 3 p., No. 1/2003

Höhle, J., M. Potuckova, 2004. Quality control for orthoimages and DEMs, http://www.i4.auc.dk/jh/QualityControl_14_11_JH_MP.pdf (accessed 28 April 2004)

Flanagan, D., 2002. *Java in a Nutshell*, 4th edition, O'Reilly & Associates, Inc., ISBN: 0-596-00283-1, 919p.

Leete, G. and E. Finkelstein, 2002. *Macromedia Flash MX for dummies*, Hungry minds Inc., New York, USA, ISBN: 0-7645-0895-4, 376 pp.

Tempfli, K., 2003. LIDAR & INSAR embedded in the OEEPE's distance learning initiative, in: Grün, A., Kahmen, H. (Eds.), *Optical 3-D Measurement Techniques VI, Volume II*, Institute for Geodesy and Photogrammetry, ETH Zürich, pp.16-22.

Voska, R., 2001, *Webgrafik-Designer*, DATA BECKER, 54 p. incl. CD, ISBN 3-8158-6492-5

Links to institutions with e-learning courses:

<http://www.aau.dk/evu/udd/msgeoinf.htm>

<http://geoworkforce.olemiss.edu>

<http://www.eurosdrr.org>

<http://campus.esri.com>

(all accessed 27 April 2004)